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BUILDING SOIL HEALTH



NDSU

EXTENSION

S O I L



HEALTH



THE ROOT *of Soil Health*

Soil health has been around for decades but has become mainstream in the past several years by being featured in almost every farming magazine, becoming a component of most farm shows and being featured in conferences and field tours across the country.

The idea behind soil health is to bring farmers, consultants, industry, state and national organizations, researchers and Extension together to better understand, protect and build the soil resource. We continue to gain a better understanding of the concepts related to soil health; however, the application of these concepts on farms can be tricky because they are very farm specific and do not follow traditional approaches being used by a majority of farming operations. As a result, we are seeing leaders in the research and educational aspects along side the applied aspects as farmers adopt and modify their approaches.

The primary reasons for adoption of soil health building practices are based around achieving very specific on-farm goals that can be measured and backed by science. Soil health, itself, is difficult to measure, but the achievement of specific goals can be researched and monitored. Some common goals include, but are not limited to, soil erosion control, water management,

efficient nutrient cycling, weed management, livestock grazing and more consistent crop yields. Wrapped into these goals are the soil health parameters we measure scientifically and evaluate visually.

For evaluating erosion, it can be documented using research tools or visually. For research, soil erosion from differently managed fields is measured. However, visually, dust storms on a windy day before crop canopy closure or after harvest, soil in the ditches during an open winter and sand blasting on young crops are visually observed. To reduce erosion, maintaining surface residue through reduced-till systems or having a living cover crop planted before, during or after crop harvest are tactics that can be used on-farm.

Another common reason farmers are adopting soil health building practices is water management. This is done by adding transpiration with a cover crop to remove water when conditions are wet, facilitating water moving down into the soil profile through root channels to recharge subsoil moisture for crop use, maintaining residue with conservation tillage to reduce evaporation for water storage and to keep salts from rising into the rooting zone. These are also parameters we evaluate with research and share with farmers using

TOPICS *covered*

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demonstration sites. After gaining trusted information, a farmer may implement the use of cover crops and reduced-tillage systems to accomplish these specific goals.

Whatever the goal, a combination of soil health building practices can be very effective. We continue to learn how to implement these practices as farmers commit to adjusting management and modifying approaches and equipment to fit their

farms. The partnership of farmers, consultants, industries, organizations and universities is what advances soil health. In North Dakota, we have strong partnerships that support the science and nurture the innovation required to adopt soil health building practices effectively. This is what makes North Dakota a leader.

Section written by: Abbey Wick, NDSU



ABBEY WICK

NDSU Extension Soil Health Specialist

EXTENSION *Profile*

Connecting farmers with resources is a primary goal for successfully getting soil health management practices on-farm. Resources may include general information about soil health, university-based research results, other farmers and consultants using specific practices and modifying equipment, or simply listening as a farmer talks through ideas. Producers have a lot to consider when changing practices, and minimizing the risk is a high priority.

Reducing tillage, diversifying rotations, including cover crops and managing salinity are not easy to accomplish on-farm. Each requires a well- thought-out plan, along with an ability to stay flexible, to adjust as conditions change. We're learning many of these practices together and are having a high level of success as we continue to move forward.

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EVALUATING SOIL HEALTH

Is My Soil Healthy?

Evaluating soil health can be challenging, but some measure is needed to determine if shifts in management practices are beneficial. Commercial methods available for measuring and monitoring soil health are in their infancy, and some of them have not been validated rigorously and calibrated across various soils. Also, collecting and interpreting the results of commercial soil health tests does not have a long history, so baseline and target values are unclear. At this point, the suggestion is to file away results from a soil health test, and use them to track changes through time rather than make management decisions immediately. The actual measured values that are part of a soil health test are also more valuable than any computed overall soil health “score” or “index”.

The single best quantitative method for monitoring soil health is a measure of soil particles aggregation because it represents all the good things happening in a healthy soil. The Cornell Soil Health Lab provides an aggregate stability test service other soil testing labs may have this capability as well.

Aggregation can be assessed visually in a field. A well-aggregated soil will have pore space, will drain well and crumble and form various-sized rounded aggregates when handled. Moist soil should not smear, and dry soil should not be too hard so that it can't be broken apart. Establishing a feel for a healthy soil will develop in time as more soils and management practices are evaluated.

Section written by: Caley Gasch, NDSU



AGGREGATION

tells us

- **Soil is staying put:** Well-aggregated soils are resistant to water and wind erosion.
- **The soil is alive:** Roots, microbes and earthworms all help build and maintain strong aggregates. If they are there and doing their job, you will see it in the soil structure.
- **The soil is a sponge:** Aggregation allows the soil to soak up and hold water, absorb equipment weight, and store soil organic matter and plant nutrients.



CALEY GASCH

*Assistant Professor of
Soil Health-Research*

RESEARCH *Profile* NDSU

Soil is complex, and soil organisms can influence nearly all soil properties yet they are sensitive to other organisms and the chemical and physical state of the soil. Understanding responses of soil biological activity to different conditions (naturally occurring or not) can be useful for identifying why soil health is compromised or enhanced.

Long-term agricultural productivity depends on soil health. North Dakotans seek hard data on how soils respond to management and how soils can be restored and conserved. NDSU Soil Health provides data on the basic condition of the soil, how it responds to change, methods for assessing and monitoring soil quality, and guidance on management strategies that use or promote soil biota to address soil health concerns.

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EVALUATING PRACTICES *for Farmers*

The premier project for the NDSU Soil Health Program is the Soil Health and Agriculture Research Extension (SHARE) Farm near Mooreton, ND. The SHARE Farm is a farmer-driven, field-scale, long-term, whole-system project that includes both research and Extension programs. The project was initiated in 2013, and this site, along with other soil health projects, has been supported with more than \$2 million dollars invested by the North Dakota Corn Council, North Dakota Soybean Council and North Dakota Wheat Commission. In 2016, the SHARE Farm was included in the National Corn Growers Association, Soil Health Partnership network of on-the-farm research and demonstration sites. It is the only site in North Dakota to be included in this partnership of 100 locations across the Midwest.

Farmer-driven and Field-scale: Farmers have the ultimate buy-in at the SHARE Farm. We gather input from farmers regularly through Extension programming and personal relationships to find out what they want to evaluate or see demonstrated. Full-scale equipment with treatments extending across the entire length of the field are used to catch variability and to understand how these practices would work in a real-world situation.

The first farmer-driven research objective identified was to evaluate tile drainage. As a result, we installed tile drainage on the north 80 acres of the field and mirrored soil health building practices being tested at the SHARE Farm on tilled and untilled portions of the field.

The next question farmers had was about the effectiveness of conservation tillage practices on high-clay soils at the SHARE Farm and commonly found in the Red River Valley. Full-scale plots were installed over tilled and untilled ground in the fall of 2015.

Questions then surfaced about the use of cover crops in rotation, how to make that work in corn and soybean crops and using cover crops to transition to no-till management on challenging soils. In 2016, we interseeded cover crops into 100 acres of corn that transitioned to no-till in 2017 to compare with traditional chisel plow, noncover crop management replicated strips. Who knows what other ideas farmers will bring to the table, but we are ready to test those ideas at the SHARE Farm.

Long-term and Whole-system: The intention of the SHARE Farm is to continue research and Extension activities for at least 10 years. Soil



health parameters are slow to change with the implementation of new management practices, and we need time to be able to evaluate the system fully. Research extends beyond soil health to include the subsequent effects of the adoption of soil health building practices with other in-field parameters such as shifts in weed, pest and disease pressures. We are evaluating the implementation of new technologies such as sensors and the effect of weather on the system. The site is outfitted with a top-of-the-line North Dakota Agricultural Weather Network (NDAWN) station that includes the standard equipment plus the capability

to measure soil moisture and temperature with depth, snowfall amounts and air temperature differences for inversion detection.

A farmer said it best: The SHARE Farm gives him a place to drive by to see how the different soil health building practices work. Farmers are adopting these practices across the state quickly as a result of what they are learning from research at the SHARE Farm and the Extension programming designed to suit their needs.

Section written by: Abbey Wick, NDSU



‘SHARE’ING *the Knowledge*

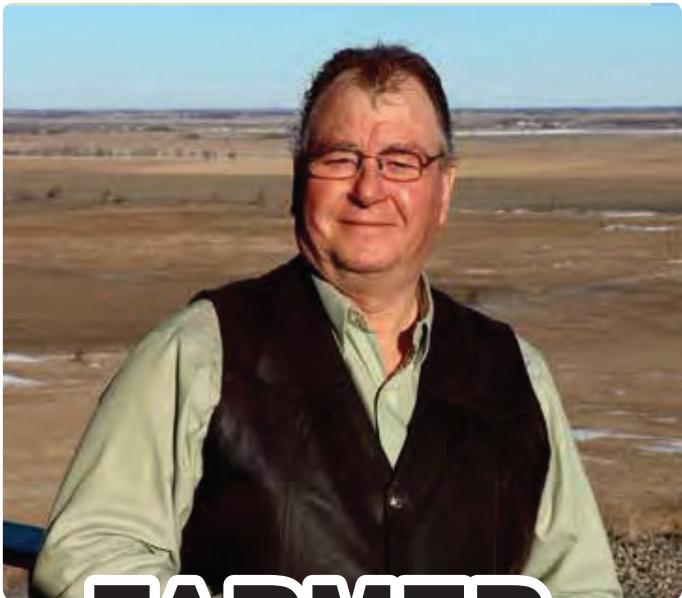
Extension programming associated with the SHARE Farm includes large and small field days and tours, winter workshops and small discussion groups called Café Talks.

The Soil Health Café Talks have been a staple of the SHARE Farm Extension program since January 2014. These informal discussion groups started after a farmer said “I need to get information in a laid-back environment where I can ask questions and hear the information multiple times, not only from NDSU but other farmers who are using these practices.”

What this farmer said has led to the development of the Soil Health Café Talks, which occur in multiple locations, at the same time and same place every other week in January and February. Each Café Talk may last up to four hours. Topics include reducing tillage, cover crops, soil fertility, livestock, economics, climate, plant disease and weed management. The conversation goes in whatever direction the farmers want to take it. Farming is a system, so we approach it that way by talking about management as a whole rather than as pieces.

SHARE FARM *by the numbers*

- **3 commodity group partners**
- **1 of 100 farms in the NCGA Soil Health Partnership**
- **5 research and Extension faculty working on-site**
- **600 farmers have visited the SHARE Farm from 2013 to 2018**
- **58 Soil Health Café Talks held from 2014 to 2018**



FARMER *Profile*

JOE BREKER

Havana, N.D.

The Brekers started using no-till in 1979 with the goal of conserving moisture and reducing soil erosion by leaving the residue on the surface. When conditions got wet, Joe adjusted his management to using excess moisture by diversifying his rotation, including cover crops and installing tile drainage on some acres.

He is reaping the benefits of long-term no-till and diverse rotation with reduced nitrogen fertilizer application rates. This is a result of high organic matter levels and efficient nutrient cycling. His tip for starting no-till or using cover crops is to shift your mindset from “I am going to give this a try” to “I am going to make this work.”

REDUCING TILLAGE *Do Not Disturb*

One tactic to build soil health is to reduce tillage. This could be in the form of one less chisel plow pass in the fall to incorporating vertical-till, strip-till or no-till on-farm. One primary concern farmers have with reducing tillage is soil warming and drying in the spring for planting. Dr. Aaron Daigh, NDSU assistant professor of soil physics, is evaluating soil temperature and moisture conditions under vertical-till, strip-till and chisel-plow management. Having residue on the surface does make the soil cooler and more moist in the spring during planting. However, reducing tillage has many other benefits that should be considered, including but not limited to, reduced soil erosion from residue





cover, moisture retention throughout the growing season, improved soil aggregation to help with water and air movement into the soils and habitat for soil biology to build aggregation and improve nutrient cycling efficiency.

To reduce the risk when transitioning to a reduced-till system, having a well-thought-out plan and a commitment to stick with the process for four or five years are required. The plan should include preparing the field by removing ruts and improving drainage prior to transitioning tillage systems. A farmer should consider fertilizer application, weed management, crop rotation and inclusion of cover crops. Soil conditions will not change immediately, so being mentally prepared for a couple of

years of challenges is important and having a developed support network will be key to staying on track. The support network should include other farmers using reduced-till systems, Extension specialists and consultants. The transition to reducing tillage is not always easy, but the benefit of maintaining soil cover to reduce erosion is a motivating factor for many farmers.

Section written by: Abbey Wick, NDSU



5 TIPS FROM *farmers*

- Manage residue coming out the back of the combine.
- Turn off the chopping head and leave corn stalks standing.
- Consider using a stripper head for wheat to leave residue standing and avoid a mat.
- Plant cover crops, especially after wheat, to help manage moisture.
- Make sure disk openers on planting equipment are sharp to cut through residue.

USING COVER CROPS *Covering Up*

Farmers are using cover crops in North Dakota to accomplish specific goals on-farm. Cover crops can be included in rotations to fill gaps when cash crops are not growing. During the time the cover crop is growing, soil is being improved through organic matter additions, roots creating channels for drainage, stimulation of the soil biological communities and capturing excess nutrients. All of these benefits are in addition to reducing erosional losses and managing weed pressures through competition. Selection of cover crops should be based on goals, the current crop growing and the next crop in rotation.

The most likely time to fit in a cover crop is after an early season crop such as small grains or pea. Typically, the field is managed with tillage or spraying herbicide after harvest, but an alternative is to plant a cover crop mix that contains cool-season species such as radish, rapeseed, flax and a small grain (volunteer or seeded). Termination of the volunteer small grain is a consideration prior to planting the cover crop mix to allow the seeded cover crops to establish well.

Cover crops also are being included in corn, soybean and sunflower phases of the rotation. Corn can be interseeded any time after the five-leaf stage to avoid competition for sunlight, moisture and nutrients. Cover crops can be broadcast into soybean before leaf drop, and winter annual cover crops, such as cereal rye (*technically termed winter rye,*

but commonly referred to as cereal rye), could be seeded after the soybean harvest. In sunflower, cover crops can be flown on after desiccation, but some farmers are trying the approach of seeding cover crops with their sunflower crop. Using cover crops after soybean and sunflower is not a common practice and is still being evaluated by NDSU and farmers.

Cover crops also can be included prior to planting a cash crop which is referred to as “planting green.” Winter rye is seeded the fall prior to having soybean in rotation. Soybean then is planted directly into the living winter rye cover crop unless dry conditions warrant the termination of the rye with herbicide prior to planting. Planting green is not currently approved by the Risk Management Agency, but we are working with the U.S. Department of Agriculture-North Dakota Natural Resources Conservation Service on getting this practice approved.

Typically, planting a broad-leaf legume into cereal rye is not an issue; however, this practice is not recommended for corn because of competition, water stress, nutrient tie-up, chemical effects from rye roots, disease and pest transfer from the rye to corn. In the case of corn, cereal rye should be terminated 14 days in advance of planting. Cereal rye also should not be seeded the fall prior to a wheat or other small-grain crop because volunteers cannot be controlled in small-grain cash crops and will contaminate the grain harvested.





Nothing is easy about adopting cover crops into a rotation, and they certainly are not the silver bullet that solve all problems. Finding the correct mixes, seeding rates, herbicide programs and fit with cash crops should be done on a farm-by-farm basis and tailored to the farmers comfort level.

Section written by: Abbey Wick, NDSU

5 WAYS TO START WITH *cover crops*

- **Set a goal.**
- **Consider the current and next crop in the rotation.**
- **Use simple mixes of species you can manage.**
- **Set up small test plots with different species.**
- **Use a shovel to see changes to the soil.**



FARMER *Profile*

DOUG, NICK AND BRAD TOUSSAINT

Wahpeton, N.D.

On their farm, the Toussaints are fitting a cover crop into every part of their rotation, which includes a small grain (wheat, winter rye or barley), corn, soybean and sunflower. They seed cover crops after the wheat harvest, interseed corn, and fly on cover crops before the soybean harvest, and are working with growing flowering cover crops at the same time as their sunflower crop to support beneficial insects and manage weeds.

Winter rye is a staple in their cover crop mix because it can be planted in the fall, successfully overwinters in North Dakota and can use soil moisture in the spring. This helps them with crop planting on high-clay soils that can get waterlogged easily. They are seeing improvements in their soils, with better drainage through the soil aggregation building and reduced erosion through residue and living plants.



INTEGRATING LIVESTOCK

Chew On This

Livestock can be an important addition for advancing soil health systems on-farm. The most obvious benefit is the nutrients that are being added to the soil through livestock grazing cover crops and corn stalks or the composting and application of feedlot manure to the fields. Livestock also can help manage residue and volunteer crops post harvest in reduced-till systems.

Farmers often include cover crops to support livestock grazing with the additional benefit of improving their soils. Typically they will include a brassica in the mix because of rapid growth, relatively high frost tolerance, nutrient scavenging and a large tap root that can break through hard pans. Marisol Berti, NDSU professor of forage and biomass crop production, recommends farmers take a closer look at cover crop species variety in their mixes because that can make a difference for biomass production. They also can try to seed cover crops as early as they can for the specific time frame selected.

Cover crops can be used for early spring grazing (late April to early June), summer grazing and haying (mid-July to early September) and late-season grazing (mid-September to mid-January). For early spring grazing, typical cover crops include winter wheat, winter triticale and winter rye that are seeded the fall prior to grazing. These cover crops could be followed by a cash crop after grazing. Summer grazing cover crops are typically full-season and primarily would be a mix of warm-season species, such as millet, sorgum-sudangrass and legumes such as pea or clover. Late-season grazing would include cool-season cover crop species, such as radish, turnip, and volunteer small grain seeded after the small grain harvest or interseeded into corn.

Including livestock isn't always an option, but if available, it should be considered as an addition to the soil health system.

Section written by: Abbey Wick, NDSU



5 TIPS FOR ESTABLISHING cover crops for grazing

- Start with a weed-free seedbed by using a herbicide pass. This also will terminate volunteer small grain to ensure the cover crops will establish well.
- Try interseeding a cover crop into corn for early establishment that provides corn stalks and a cover crop to graze post-harvest.
- Seed late-season cover crops (after the small grain harvest) before Aug. 15 and use cool-season species to be cost-effective and get adequate growth.
- Be aware of herbicide residual and select cover crop species appropriately.
- Try to use corn stalks and cover crop fields in combination to balance the diet of cattle.

FARMER Profile

BRUCE, TYLER AND KYLE SPEICH

Millnor, N.D.

The Speich Farm uses a whole-systems approach on the farm. The Speichs have incorporated no-till, strip-till, crop rotation, perennial crops and cover crops with their livestock operation to maintain soil conditions and crop yields, as well as maximize weight gain on cattle and reduce time spent in the feedlot. After a small-grain cash crop, they will seed cover crops, including radish, turnip, winter rye and dwarf Essex rapeseed, for grazing in the fall and early winter. They also have interseeded corn with this same mix to graze cattle on cover crops and corn stalks. In mild winters, they have been able to keep the cattle grazing on cover crops until late January.



MANAGING SALTS

Don't Be So Salty

Salinity affects up to 90 percent of farmers in North Dakota, significantly reducing yields of cash crops such as soybean and corn grown on salt-affected areas. Salts are naturally occurring in our soils and are moved by water throughout the soil profile. The salts will accumulate in the rooting zone as a result of evaporation pulling dissolved salts in water toward the soil surface. The key to managing salts is to manage the water that transports them.

That being said, nothing is easy about managing salinity. It requires patience to avoid frustration and flexibility to adjust management approaches as conditions change. We have been working with farmers on a variety of approaches, depending on the level of salinity, including reducing tillage, improving drainage, using more salt-tolerant cash crops, including a cover crop in rotation, seeding a full-season cover crop, establishing perennial species and managing weeds like a cover crop. No single approach or recipe is available for managing these areas, and often a combination of approaches will be most successful.

Reducing tillage is critical to managing salinity. Tillage opens up the soil and buries residue which increases evaporation pulling water carrying salts toward the surface. On saline headlands, a

simple approach is to avoid tillage and direct seed into those areas.

Improving surface drainage is another simple step. Use ditches to keep water moving off the field. Installing tile also can improve conditions. To maximize salt leaching, reducing tillage and diversifying rotations will help build soil structure and get more water moving to tile lines.

Some crops are more tolerant to salts than others; barley is one of the most tolerant crops, followed by wheat, corn and soybean. An economic calculator on the NDSU Soil Health webpage can help farmers make decisions on which crop to grow based on a measured soluble salt level from soil tests, inputs and crop prices.

Having a small grain in rotation also creates an opportunity to include a cover crop for additional moisture use and increased residue cover to reduce evaporation. Additionally, interseeding corn on slightly saline ground is a great way to fit a cover crop in rotation.

On some acres where growing a cash crop is not cost-effective, a full-season cover crop could be used. Barley, winter rye, radish, dwarf Essex rapeseed and sunflower are excellent choices to include in a mix.



***Salinity effects
up to 90% of
farmers in
North Dakota***



Select cover crops that do not cause issues with cash crops growing in the rest of the field, and do not use expensive mixes to keep costs down.

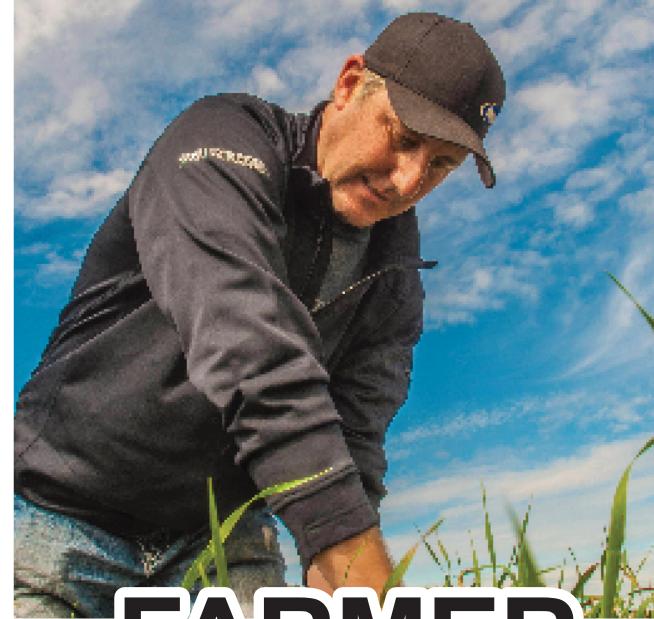
On highly saline areas, establishing a perennial may be the best approach. Grasses should be managed with timely cuttings to keep using water. Stagnant or dead grasses can lead to additional salts pushing out along the edge of the grassland.

Lastly, the only option may be to manage weeds in those areas with a batwing mower to build mulch and keep weed seeds from moving across fields. Seed barley in the spring followed by a winter rye/barley mix in the fall in these areas to eventually out-compete weeds.

Section written by: Abbey Wick, NDSU

5 STEPS TO MANAGE *salts*

- Soil test salty parts of the field. Use the soluble salt number from a soil test to guide management decisions.
- Improve surface and/or subsurface drainage in salt-affected fields.
- Use more salt-tolerant cash crops, such as barley or wheat, instead of corn and soybean.
- Use as much water as you can throughout the growing season by following a cash crop with a cover crop.
- Consider a full-season cover crop, perennial grasses or alfalfa on areas with high levels of salt.



FARMER *Profile*

TERRY WEHLANDER

Delamere, ND

Terry uses a multitool approach of no-till, crop selection, cover crops, weed management, perennial grasses and alfalfa to manage salt-affected parts of his fields. He seeds his high-salt areas with a full-season cover crop mix early in the spring to use moisture throughout the growing season, then follows with another cover crop mix in late summer to get additional water use. On some of his other fields with patches of lower salt levels, he will interseed corn and follow small-grain cash crops with cover crops to keep salts out of the rooting zone.

Although salinity affects just a small percentage of the land he farms, he feels actively managing these areas is important to keep them from spreading into productive parts of his fields, where he focuses on maximizing crop yields.

SOIL FERTILITY

Get Credit Where It's Due

Fertilizer application rates are important for crop productivity on-farm, and their correct management is important to protect natural resources. Soil health building practices such as no-till, having a diverse crop rotation and the inclusion of cover crops may result in better crop nutrient use efficiency. Dave Franzen, NDSU Extension soil specialist, has been conducting research across North Dakota since 2005 to modernize corn, sunflower and spring wheat/durum fertilizer application rates. State-specific recommendations for soybean, field pea, lentil, canola, dry edible bean, barley, rye and winter wheat were updated in the summer of 2017.

A major finding in Dave's research is that recommendations in North Dakota are not yield-goal based. Similar nitrogen

application rates are required in a low-crop-yielding environment as in a high crop-yield environment. This is the result of nitrogen mineralization rates in the soil and nitrogen uptake efficiency of the crop due to the same conditions that result in high or low yields: for example, low nitrogen mineralization rates and nitrogen uptake efficiency in a low-yielding environment and high nitrogen mineralization rates and highly efficient nitrogen uptake in high yielding environments.

A 50-pound nitrogen credit/savings also is granted for corn in long-term no-till soils under a diverse rotation based on comparisons of nitrogen rate studies in conventional till vs. long-term no-till field sites. This is a cost reduction of \$15 to \$30/acre depending on

nitrogen fertilizer prices for the farmer and is also a benefit for improving groundwater quality.

An important soil fertility consideration is reducing soil erosion losses. Practices that protect the soil with residue (no till/strip-till) and increase soil coverage by plants (rotation and cover crops) can reduce the amount of soil lost from fields greatly, which increases soil fertility through time.

Section written by: Dave Franzen, NDSU

 [ndsu.edu/soils/personnel/faculty/dr_david_franzen/](https://www.ndsu.edu/soils/personnel/faculty/dr_david_franzen/)

A 50-pound nitrogen credit
translates to a cost reduction of **\$15 to \$30 per acre.**

FARMER

Profile

TONY WAGNER

Jamestown, N.D.

Tony Wagner learns about how a new management approach will work on 40 to 60 acres before he applies it to the whole farm. He started no-till in 2003 by using this approach on some sandy soil following a pea crop and with the incorporation of cover crops to his system. The practices he is using have led to more efficient nutrient cycling in his soils, resulting in reducing fertilizer application rates.

On his farm, Tony has tested and is using a 30 pound/acre (lb/ac) nitrogen credit following a pea crop and a 30 lb/ac nitrogen credit for nutrient scavenging by cover crops. The backup plan when using these credits is to side-dress in season if he thinks he's going to be short. Nitrogen credits should be farm-specific, but this is just one example of how no-till, rotation and cover crops can make a system more efficient and reduce costs while building soil health.



OIL SPILL, *Now What?*

Land and water resources in North Dakota are inevitably impacted by oil development. In the case of an oil spill, many of the general principles used to build soil health can be applied to the remediation process to return oil-affected soils to agricultural production. Tom DeSutter, NDSU associate professor of soil science, has been working alongside industry and landowners since 2013 to remediate an oil spill in the Tioga, N.D. area. Through this particular site, we are learning valuable information on how to remediate these areas effectively so that they can be put back into agricultural production.

Strategies for bringing the soil back to its original productivity will be decided upon between the landowner and the responsible company. In many cases, oil-impacted subsoil and topsoil will need to be remediated to levels that protect water resources. Many in-situ (soils stay in place) and ex-situ (soils removed, treated on site and replaced; or hauled away and treated off-site) remediation strategies are available to remove oil from soil materials, and some of these strategies take longer than others. Once remediation of the oil has been completed, then reclaiming the productivity of the soil can occur.

Some of the practices being used at the Tioga site include excavation and treatment of materials, including topsoil containing oil, with a thermal desorption unit to clean the material. This process exposes soil to high temperatures to volatilize the hydrocarbons in the oil and remove them. As a result, organic matter, water-holding capacity and biological activity are very low in treated soils being returned to the site. Additionally, compaction and loss of soil aggregation can be an issue from running heavy equipment on-site during the removal, treatment and replacement of soil materials.

Manure applications and cover crops in rotation are being applied on-site to rebuild organic matter, increase water-holding capacity, stimulate biological activity and alleviate compaction. Reduced-tillage also is being used to rebuild soil aggregation. Depending on the location and severity of the spill, the remediation of oil-affected areas may take days, months or years. Since crop yields and rangeland production are annual, the evaluation of remediation approaches may require multiple years of monitoring.

Section written by: Tom DeSutter, NDSU Associate Professor

“Saltwater and oil releases will be a part of our life in western North Dakota. It is so important to understand how to bring the soil back into a productive state; much depends on the severity of the release. We have taken so much for granted, although we have always tried to have processes in place that encourage soil health. We appreciate having the guidance of NDSU to help us work through how soil that has gone through a thermal desorption process can be made productive again, along with understanding how water will infiltrate back into ground that has been disturbed. I think people need to be more aware of this issue. We really have been impressed with the young bright minds of the students involved in our project and are very proud of what they have accomplished. We would encourage people to search out and read the papers they have had published.”

- PATTY JENSEN

Landowner, Tioga, N.D.

5 CONSIDERATIONS FOR *Remediation*

- Report all spills to the proper authorities, including the North Dakota Department of Health.
- Be patient, successful remediation takes time.
- Use cover crops or mulches to help control erosion.
- Soil biology should recover after the proper soil physical and chemical properties are in place.
- Ask questions to understand the remediation procedures that will be used.



FARMER *Profile*

**STEVE
AND PATTY JENSEN**

Tioga, N.D.

Steve and Patty have deep roots in soil health with the incorporation of minimum-till on their farm in 1989. They have a diverse crop rotation that includes garbanzo bean, pea, spring wheat, canola, sunflower and durum wheat. They have used cover crops on their farm and select mixes that are healthy for the 100 head of cattle they run and their soil.

They are landowners who are working with the industry, regulators and NDSU on remediating an oil pipeline leak that which occurred on their land. They have partnered with NDSU to evaluate management approaches, which incorporate soil health principles to return productivity to the affected soils. They hope information produced from the research being conducted on their land will lead to solutions for other landowners in similar situations.



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